(A) One way ANOVA table :- (Single factor ANOVA)

It is convenient to summerize the result of an analysis of variance in a table.

Source of variation	Sum of Square (SS)	DOF	Mean Square MS	F-Ratio
Between Samples	SS_B	$K-1$	$MS_B = SS_B/DOF_B$	MS_B/MS_W
Within Samples	SS_W	$n-K$	$MS_W = SS_W/DOF_W$	
Total	SS_T	$n-1$		

(Qn)

$$\frac{x_1}{1} \qquad \frac{x_2}{2} \qquad \frac{x_3}{2}$$

$$\begin{array}{ccc} 2 & 4 & 3 \\ 5 & 2 & 4 \end{array}$$

Ans

Step-1: $H_0: M_1 = M_2 = M_3$

$H_a: M_1 \neq M_2 \neq M_3$

$\alpha = 0.05$

Step-2: D of between $= (k-1)$

where, $k = $ No of groups

So, $k = 3$; $3-1 = 2$ //

D of within $= (n-k)$, where $n = $ No of scores

$n = 9$

So, $(n-k) = (9-3) = 6$ //

D of Total $= (n-1)$ so, $(9-1) = 8$ //

Table value (Refer the table)

D of between $\longrightarrow$ Numerator

D of within $\longrightarrow$ denominator

so Table value $= 5.14$ //

Step-3:

$$\frac{x_1}{1} \qquad \frac{x_2}{2} \qquad \frac{x_3}{2} \qquad \frac{x}{1}$$

$$\begin{array}{cccc} 2 & 4 & 3 & 2 \\ 5 & 2 & 4 & 5 \\ \overline{\sum x_1 = 8} & \overline{\sum x_2 = 8} & \overline{\sum x_3 = 9} & 2 \\ \bar{x}_1 = 8/3 & \bar{x}_2 = 8/3 & \bar{x}_3 = 9/3 & 4 \\ = 2.67 & = 2.67 & = 3 & 2 \end{array}$$

$$\begin{array}{c} 2 \\ 3 \\ 4 \\ \overline{\sum x = 25} \end{array}$$

$G\bar{x} = 25/9$

$= 2.78$

Step-4: (1) Calculate Sum of square Total

(SST):-

SST $= $ Sum Square $(x_i - G\bar{x})$ of Sum of square Total $(x_i - G\bar{x})^2$

x_1	x_2	x_3	SS_T
$(1-2.78)^2$ $= 3.16$	0.60	0.60	$3.16 + 0.60 +$ $4.94 + 0.60 +$
$(2-2.78)^2$ $= 0.60$	1.49	0.05	$1.49 + 0.60 +$ $0.60 + 0.05 +$
$(5-2.78)^2$ $= 4.94$	0.60	1.49	1.49 // 13.56

(II) <u>Calculate sum of square within (SS_w):-</u>

$SS_w = $ Sum of square $(x_i - \bar{x}_i)$ of

Sum of square within $(x_i - \bar{x}_i)^2$

x_1	x_2	x_3	SS_w
$(1-2.67)^2$ $= 2.78$	$(2-2.67)^2$ $= 0.44$	$(2-3)^2$ $= 1$	$2.78 + 0.44 +$ $5.44 + 0.44 +$
0.44	1.78	0	$1.78 + 0.44 +$ $1 + 0 + 1$ //
5.44	0.44	1	13.33

(III) <u>Calculate Sum of square between (SS_B)</u>

$$SS_B = SS_T - SS_w = 13.56 - 13.33 = 0.22$$

Step-5 :- <u>Calculate Mean variance</u>

(I) Mean square between (MS_B)

$$\Rightarrow MS_B = SS_B/DOF_B = 0.22/2 = 0.11$$

(II) Mean square within (MS_w)

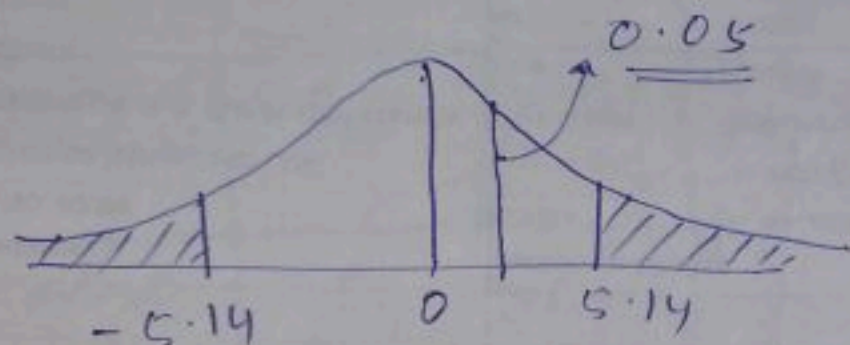$$\Rightarrow MS_w = SS_w/DOF_w$$
$$= 13.33/6 = 2.22 //$$

<u>Step-6</u> <u>Calculate f. Ratio:-</u>

$$f = MS_B / MS_W = 0.11 / 2.22 = \underline{\underline{0.05}}$$

critical factor of f value from the table $= \underline{\underline{5.14}}$

<u>Conclusion:-</u>

Calculated value $<$ Table value

$$0.05 < 5.14 \qquad accepted$$

Hence H₀ fails to reject ie, H₀ is ↗.

So there is no significant difference between all the variable of three different series.

(B) Two way ANOVA table:-
  (Two factor Analysis)
  It takes the following forms.

Source of Variance	Sum of square (SS)	D of	Mean square (MS)	F Ratio
Between Rows	SS_R	$(r-1)$	$MS_R = SS_R / Dof_r$	$\dfrac{MS_R}{MS_E}$
Between Columns	SS_C	$(c-1)$	$MS_C = SS_C / Dof_c$	$\dfrac{MS_C}{MS_E}$
Error Residuals	SS_E	$[(r-1) \times (c-1)]$	$MS_E = SS_E / Dof_E$	
Total	SS_T	$(rc-1)$		

On

fertilizers / seeds→	a	b	c
W	6	5	5
X	7	5	4
Y	3	3	3
Z	8	7	4

Step-1 Calculate Correction factor:-

Correction factor $= T^2/N$

where, $T = $ Sum of all values

$(6+7+3+8+5+5+3+7+5+4+3+4) = 60$

$N = R \times C = 4 \times 3 = 12$

Corretn factor $= (60)^2/12 = 300$ //

Step-2 Calculate Sum of Square Total

(SS_T):-

$SS_T = ($ Total Sum square $-$ Corretn factor$)$

	a	b	c	
W	36	25	25	
X	49	25	16	Total
Y	9	9	9	Sum square
2	64	49	16	$= 332$

$SS_T = 332 - 300 = 32$ //

Step-3 Calculate SSc, SS_R & SS_R

	a	b	c	ΣR	$SSR = SSR/n_i$
W-	6	5	5	16	$16^2/3 = 85.33$
X	7	5	4	16	$16^2/3 = 85.33$
Y	3	3	3	9	$9^2/3 = 27$
2	8	7	4	19	$19^2/3 = 120.\frac{1}{33}$
Σc	24	20	16	//////	$SSR \boxed{317.6}$
$SSc = \frac{Sc^2}{n_i}$	$\frac{24^2}{4} = 144$	$\frac{20^2}{4} = 100$	$\frac{16^2}{4} = 64$	$SSc = \boxed{308}$	

Step-4

(i) <u>Calculate SS. between Column treatment:-</u>

$$= SS_c - \text{Correction factor}$$
$$= 308 - 300 = 8 //$$

(ii) <u>Calculate SS between Row treatment:-</u>

$$= SS_R - \text{Correction factor}$$
$$= 317.66 - 300 = 17.66 = 18 //$$

(iii) <u>Calculate SS residual & Error:-</u>

$$= SS_T - (SS_c + SS_R)$$
$$= 32 - (8 + 18) = 6 //$$

Step-5

ANOVA Table

Source of Variation	SS	Dof	MS	F-Ratio
Between Row	18	$(4-1) = 3$	$18/3 = 6$	$6/1 = 6$
Between Column	8	$(3-1) = 2$	$8/2 = 4$	$4/1 = 4$
Residual Error	6	$3 \times 2 = 6$	$6/6 = 1$	
Total	32	$(3 \times 2) - 1 = 5$		

N.B :- Critical value (Refer to table)
D.of of (Row, Residual Error) are
numerator & denominator respectively
as well as (Column, Residual Error) are
also numerator & denominator
respectively. i.e $f(2,6) = 5.14 //$
& $f(3,6) = 4.76 //$

(30)

Decision :-

Column :-

Hence f. value calculated in terms of between Columns < critical value of Column

$$\Rightarrow 4 < 5.14$$

Hence H_0 fails to reject (H_0 accepted)
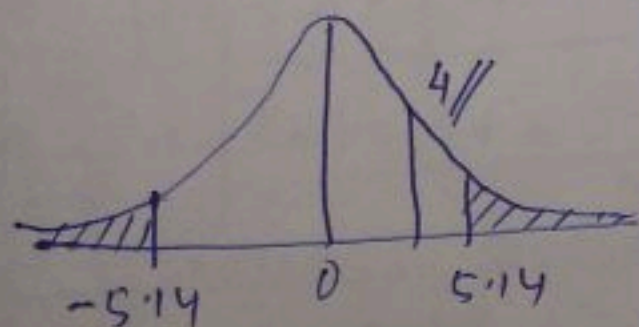
So there is no significant difference between seeds.

Row :-

Hence f. value calculated in terms of row > critical value of row

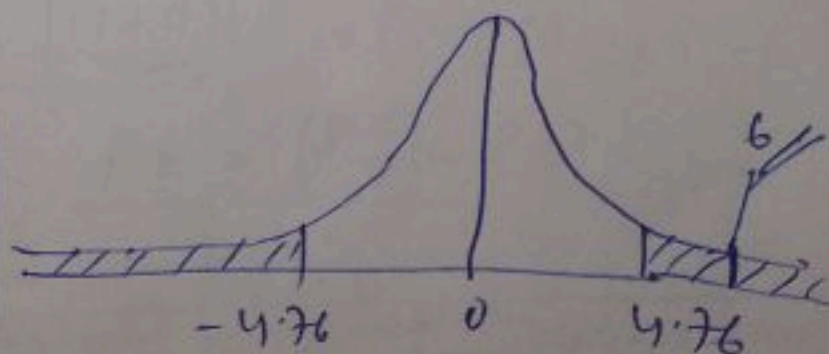$$\Rightarrow 6 > 4.76$$

Hence H_0 is rejected

So there is significant difference between the fertilizers

(Seeds) | (fertilizer)

-5.14   0   5.14

Accepting
H_0

-4.76   0   4.76

Rejected
H_0.

$\nu_2 \setminus \nu_1$	2	3	4	5	6	7	8	9
				The F - Distribution with $\alpha = 0.05$				
2	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38
3	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81
4	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00
5	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77
6	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10
7	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68
8	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39
9	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18